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Indian Standard

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भाग 3 एल्युमिनियम फास्फाइड (फॉस्फीन)

(पहला पुनरीक्षण)

Fumigation of Agricultural Produce — Code of Practice

Part 3 Aluminium Phosphide (Phosphine)

(First Revision)

ICS 65.040.20

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Foodgrains, Allied Products and Other Agricultural Produce Sectional Committee, FAD 16

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Foodgrains, Allied Products and Other Agricultural Produce Sectional Committee had been approved by the Food and Agriculture Division Council.

Use of fumigants becomes necessary for pest control in various commodities including agricultural produce. Fumigants are, however, effective only under airtight conditions and, therefore, airtight condition is a pre-requisite for carrying out the fumigation. Further, it is necessary to choose the fumigant taking into consideration the likely reaction of the fumigant with the material to be fumigated, possible hazards to the operators, the area where the fumigation is to be carried out, and the time available for effecting fumigation.

Aluminium phosphide (ALP) is a solid fumigant and a highly toxic pesticide which is commonly used for fumigation. Phosphine is very toxic to all forms of animal life and exposure of human beings even to small amounts should be avoided. Therefore, use of Aluminium phosphide tablets is restricted. Aluminium phosphide fumigation operation may be carried out either by government experts or commercial pest control operators whose expertise is approved by the Plant Protection Adviser to the Government of India as mentioned in NSPM 22 'Guidelines for Assessment, Audit and Accreditation of Fumigation Agencies for Undertaking Aluminium Phosphide Fumigation' published by Directorate of Plant Protection, Quarantine & Storage.

This standard (Part 3) is one of the series of Indian Standards on code of practice for fumigation of agricultural produce. This standard covers aluminium phosphide. It is hoped that adoption of these standards by storage units and export inspection agencies, both in the public and private sectors, will promote efficiency, economy and safety. The other parts published in this series are:

Part 1 Methyl bromide
Part 2 Ethylene Dibromide [Withdrawn, as the fumigant has been banned vide S.O. 682 (E) dated 17th July 2001]
Part 4 Ethylene dichloride and carbon tetrachloride mixture
Part 5 General Requirements

This standard was first published in 1974. The standard is being revised to incorporate latest technological developments in the field of fumigation of agricultural products and the major changes include:

a) Physical characteristics of aluminium phosphide have been detailed;
b) Minimum recommended dosage of aluminium phosphide has been reduced for optimum application;
c) Factors affecting dosage of aluminium phosphide has been included; and
d) Method of fumigation has been modified.

The composition of the committee responsible for the formulation of this standard is listed in Annex A.

In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'.

Indian Standard

FUMIGATION OF AGRICULTURAL PRODUCE — CODE OF PRACTICE

PART 3 ALUMINIUM PHOSPHIDE (PHOSPHINE)

(First Revision)

1 SCOPE

This standard (Part 3) describes general properties, dosage, duration of exposure, precautions in handling and method of fumigation with aluminium phosphide preparations or formulation for pest control in stored agricultural produce and inputs.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards:

IS No.	*Title*
IS 6151 (Part 1) : 2020	Storage management code: Part 1 Terminology (*first revision*)
IS 6438 : 1980	Specification for aluminium phosphide formulations (*first revision*)
IS 9503 : 1988	Specification for aluminium bottles for liquid pesticides (*first revision*)
IS 14611: 2016	Multilayered cross laminated sheets/tarpaulins/covers/agricultural films — Specification
IS 15219 : 2002	Aluminium phosphide powder formulation

3 TERMINOLOGY

For the purpose of this standard, definitions given in IS 6151 (Part 1) shall apply.

4 GENERAL DESCRIPTION AND PROPERTIES OF THE FUMIGANT

4.1 Aluminium phosphide are available in the form of tablets, pellets or sachets. All these formulations slowly release phosphine, a hazardous inflammable fumigant by reaction with the moisture in the surrounding atmosphere. The tablets release above 33 percent by mass of phosphine gas. It contains aluminium phosphide and ammonium carbamate or any other base safe for foodgrains and human life.

4.2 Properties of Phosphine Gas

Chemical formula	PH_3
IUPAC Name	Phosphane
Boiling point	-87.4 °C
Freezing point	- 133.5 °C
Molecular weight	34.04
Specific gravity:	
Gas (air 1)	1.214
Liquid (water 1)	0.746
Latent heat of vaporization	102.6 Cal/g
Solubility in water	26 ml/100 ml at 17 °C
LEP (Lowest Explosive Point)	1.79 % *v/v* or 17900 ppm or 26.1 gm/m^3
Method of evolution as fumigant	From the preparations of aluminium phosphide
Odour	Pure phosphine is odourless. However, garlic or carbide odour is detectable due to impurities such as diphosphines and arsine

5 DOSAGE AND EXPOSURE

5.1 Minimum Recommended Dosage

The minimum recommended dosage of aluminium phosphide is 2 g to 3 g phosphine cubic meter (two to three tablets per cubic meter) for agricultural produce. For fumigation of empty RCC roof warehouses or godowns, the recommended dosage is 1.5 g phosphine per cubic meter (1.5 tablets per cubic meter or 4.5 g aluminium phosphide per cubic or 450 g of aluminium phosphide tablets per 100 per cubic meter).

5.2 Factors Affecting Dosage of Aluminium Phosphide

Fumigant dosage given on volume basis differs depending on commodity type (exceptionally sorptive commodities such as paddy and pulses, require higher dosages), pest factor (higher dosages and longer exposure period needed when *Trogoderma granarium,* khapra larvae or groundnut bruchid, *Caryedon serratus* are the target insects), temperature conditions (lower the temperature, longer is the exposure period as insect development i.e., from egg to larval stage, is highly influenced by temperature), and pest status (normal or phosphine-resistant).

NOTE — Refer label and applicator's manual before aluminium phosphide (phosphine) application.

5.3 Decomposition of a tablet takes 2 days to 3 days depending on temperature and humidity conditions (and grain moisture content is 10 percent or more). When the temperature and humidity conditions are lower than 15 °C and 30 percent respectively, complete decomposition may take more than 3 days. The recommended minimum exposure period is 7 days at 25 °C and above. For fumigations carried out at lower temperatures i.e., below 25 °C, the exposure period has to be extended to 10 days to 14 days.

6 MATERIAL TO BE FUMIGATED

6.1 Aluminium phosphide may be employed with advantage for fumigation of cereals, pulses, spices, oilseeds, dried fruits, tree nuts, coffee beans, cocoa beans, oilseeds, oilcakes, rice bran, seeds, tobacco and other agricultural commodities.

6.2 Aluminium phosphide may also be employed for fumigation of RCC roofed warehouse, godown/sheds (where sealing can be properly done) and rat burrows.

7 AVAILABILITY

7.1 Tablets (3 g each) conforming to IS 6438 and pellets (0.6 g each) are packed in a leak-proof, air-tight, seamless extruded aluminium bottle conforming to IS 9503. In the case of powder formulation, the active ingredient is enclosed in a permeable sachet (paper bag, 34 g each) conforming to IS 15219.

8 METHOD OF FUMIGATION

8.1 Equipment

8.1.1 *Gas-Mask with Suitable Canister Containing Specially Treated Activated Carbon*

8.1.2 *Fumigation Covers with Pulley and Strings*

8.1.3 *Sand Snakes*

8.1.4 *First-Aid Kit*

8.1.5 *Rubber Gloves*

8.1.6 *Phosphine Leak Checker*

8.1.7 *Phosphine Gas Monitor*

8.2 Fumigation in Stacks

8.2.1 Make the stacks to uniform height. Measure the dimensions (length, width and height) of stacks preferably after sheeting/covering with fumigation sheet (*see* IS 14611), calculate the volume and apply as g of phosphine/volume in m^3. While dosing, the tablet should not be heaped. Tablet should be spread out evenly on a tray/kraft paper/enamel tray, so that residual material can be collected at the end of the fumigation for proper disposal after deactivation. When the stack has been built on wooden pallets, the tray containing the tablets can be placed at the base of the stack. In absence of wooden pallets as dunnage, the tablets held in thin cloth bags (about 10 tablets per bag) may be distributed along the four sides of the stack. Aluminium phosphide sachet or powder formulation (34 g sachet releases 11 g phosphine) provides ease of application and convenient to dispose after the treatment. The major advantage with sachet formulation is that the residual/unspent powder is retained in the pouch itself and therefore, there is no product contamination. The operators should wear the gas-mask and hand gloves before handling the tablets or sachet. After dispensing the fumigant, cover the stack with the fumigation cover immediately and make it airtight by pressing the sheet/cover all around with sand snakes of 1 m length and 15 cm diameter filled with about 80 percent dry sand. The operation should be completed within half-an-hour of the placement or exposure of the tablets/sachet. Check for any leakage of the fumigant around the stack using an electronic phosphine leak checker and rectify the leakage.

8.2.2 Whenever aluminium phosphide fumigation is carried out, immediately after dosing, a placard or warning sign board with details of fumigant used, name of fumigation agency, contact number etc. should be displayed in such a way it is clearly visible to everyone. Preferably the fumigated area be also cordoned with ribbon barricades.

8.2.3 During the fumigation period it is important to measure phosphine gas concentration inside the enclosure at 24 or 48 hr intervals using high range (1 ppm to 2 000 ppm) phosphine monitor. The target terminal/seventh day phosphine concentration must be 500 ppm or more. However, in case of Trogoderma or other pests which are tolerant, the terminal concentration must be 1 000 ppm or more. For longer exposure period of 10 days to 14 days, a reduced target concentration of about 300 ppm is adequate for a successful treatment.

8.2.4 After the exposure period of 7 days (*see* **5.2**), lift the cover partially and allow the aeration for at least once in three hours after which remove the cover completely. Allow the stocks aeration till phosphine gas concentration around the stack drops to 0.3 ppm or less. Aeration should be done wearing appropriate breathing apparatus i.e., a gas-mask fitted with right type of canister or self-contained breathing apparatus (SCBA).

8.3 Fumigation in Godowns

8.3.1 Empty storage areas (RCC roofed warehouses) and empty silos can be fumigated with aluminium phosphide tablets or sachet. Close the doors and ventilators of the godown and make the structure airtight by fixing polyethylene sheets cut to the sizes of doors and ventilators on them. Lock from outside all the doors except the exit door. After sealing sources of gas loss/leakage, required quantity of tablets/ pouches based on dosage arrived on total volume basis are dispensed at various points on suitable substrates (trays/kraft papers/cardboard sheets) held on floor. All lights and electrical motors within the treated area must be turned off. Doors leading to the fumigated space must be closed, sealed and post warning placards/ ribbon barricades. At the end of 7 days of exposure period open windows, vents etc. and fumigated structure allowed to aerate. The structures should not be entered without proper respiratory protective equipment or breathing apparatus until phosphine concentration inside is below the threshold limit value (0.3 ppm). Collect the spent residual dust and dispose it off after wet deactivation. Dispose used aluminium phosphide cans/flasks after crushing or puncturing.

8.4 Fumigation in Bulk Storage Structures

8.4.1 Make the bins or other bulk storage structures completely airtight. Dispense the aluminium phosphide tablet or sachet by surface application or insert the required number of tablets at various depths into the agricultural produce by means of a suitable applicator (perforated pipes or by a special probe of 5 ft to 15 ft length). If the grain depth is more than 30 ft, recirculation will be required following surface application or probed. After an exposure of 7 days, open the structure and allow aeration for about 6 hours.

NOTE — In case of fumigation in silos, the tablets may be inserted in the storage bins by placement at regular intervals, on conveyor belts conveying grain into bins.

8.5 Fumigation of Rat Burrows

8.5.1 Carry out the survey of the place where burrow fumigation is to be undertaken. Close all the openings of rat burrows with earth, preferably in the evening. Next morning examine these burrows and find out the number of the burrows reopened. Mark all the reopened burrows as live burrows for fumigation.

8.5.2 Carry out the fumigation of live burrows either in the morning or in the evening then the rats may be resting inside these burrows. Close firmly with earth all the openings except one opening of the live burrows. Insert two 0.6 g tablets deep into each burrow and close the same. Re-examine the burrows the following day. In case any of the burrows have been reopened, repeat the fumigation process.

9 PRECAUTIONS

9.1 The aluminium phosphide tablets on being exposed to atmosphere start releasing the phosphine gas. The fumigation work should, therefore, be planned in such a manner that the operation of placement of tablets, covering with fumigation covers, closing the doors and ventilators should be completed in about 30 minutes. To ensure uniform and speedy distribution of tablets, the points of application should be decided in advance. Ensure that no person is allowed in the premises within 30 minutes from the beginning of the operation.

9.2 The tablets start crumbling after about 30 minutes of exposure to atmosphere. This should be taken as a warning and as the time limit of completion of the fumigation operation.

9.3 Phosphine reacts with all metals, and specially with copper or copper - containing equipment;

especially electrical apparatus may be severely damaged. Therefore, all copper-containing equipment and parts in the godowns or other structures should be protected before the treatment starts.

9.4 The daily exposure to the fumigant of an operator should not exceed 0.3 ppm. Short-term exposure limit should not exceed 1 ppm.

9.5 The operator undertaking the fumigation should invariably wear the gas-mask with a canister containing specially activated carbon for protection against gases.

9.6 The operator should also wear gloves when dispensing tablets by hand.

9.7 Odour of the fumigant should not be relied upon as an indication of poisonous concentration of the fumigant.

9.8 Smoking or touching food at any time during the application of the fumigant should be strictly prohibited.

9.9 The residual limit of phosphine in foodgrains should not be more than 0.1 ppm.

10 SYMPTOMS OF POISONING AND FIRST-AID MEASURES

10.1 Symptoms of Poisoning

Nausea, pain in chest or intestines, diarrhoea, vomiting, fatigue, etc, which may be followed by dry cough, intense thirst, pain in limbs, enlarged pupils, etc.

10.2 First-Aid

Remove the operator out of the contaminated atmosphere into the open air. Make him sit or lie down. Keep him warm, if necessary, with blankets.

10.3 Treatment

Giving oxygen with oxygen breathing equipment is recommended. Administer a cardiac tonic and a drug to stimulate blood circulation.

10.3.1 In case of pulmonary oedema, a hypertonic solution of glucose should be injected.

ANNEX A
(*Foreword*)

COMMITTEE COMPOSITION

Foodgrains, Allied Products and Other Agricultural Produce Sectional Committee, FAD 16

Organization	*Representative(s)*
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